National Aeronautics and Space Administration

technology opportunity

Lithium Polymer Batteries

A rod-coil polymer that combines high ionic conductivity with dimensional stability

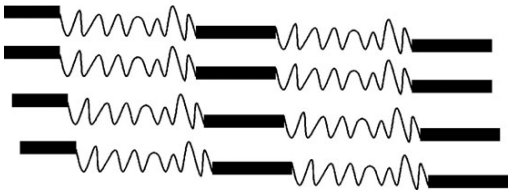

Figure 1a. Sketch showing the separate rod and coil phases of this material.

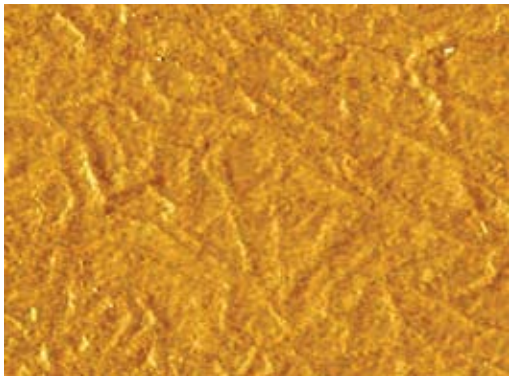

Figure 1b. AFM image showing modulus differences for the "stiff" rods and flexible coils.

Scientists at the NASA's Glenn Research Center have developed an electrolyte material that enables solid polymer lithium batteries to operate at room temperature. Solid polymer lithium batteries offer many advantages over other battery designs. In particular, Glenn has demonstrated significant improvements in ionic conductivity and mechanical integrity, both of which are important for battery and fuel cell applications.

Benefits

- **Low cost:** Offers a design that eliminates the need for elaborate packaging
- **Light weight:** Features a small footprint, lowering weight and reducing costs
- **High specific energy:** Able to store large amounts of energy in a smaller package
- **Improved safety:** Reduces flammability concerns over prior art
- **Flexible design:** Can be used for a variety of battery and fuel cell applications in a wide temperature range

Applications

- Electrolyte for solid polymer lithium batteries
- Proton exchange membrane for fuel cells

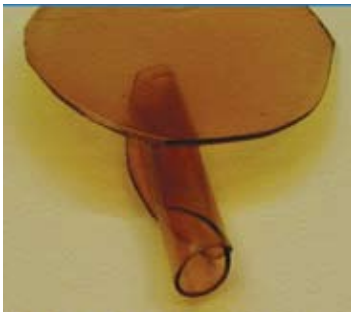

Figure 2. Samples of material with good conductivity and material integrity.

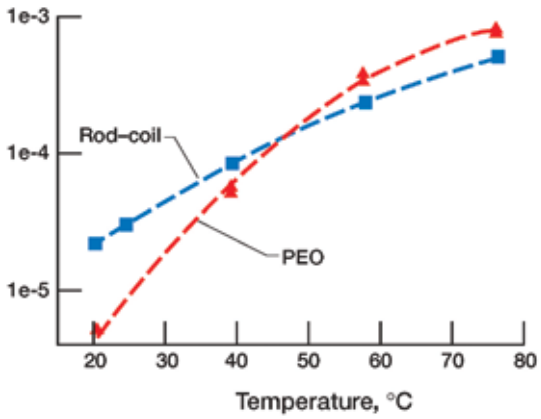

Figure 3. Conductivity versus temperature curves.

Technology Details

How it works

Glenn's new material is comprised of a series of rod-coil block copolymers in which rigid polyimide rods alternate with very flexible coils of polyethylene oxide (PEO). Figure 1 shows a sketch of the rod-coil structure and an atomic force microscope (AFM) image of a rod-coil sample. Because the rods and coils are incompatible, the blocks tend to phase separate. The result is a polymer with nanoscale channels of ionically conducting PEO alternating with concentrations of the rigid rods. The rod regions form the mechanical support for the conducting PEO coils, resulting in a material with both good conductivity and mechanical integrity. Figure 2 shows two samples of this material, with one rolled up to demonstrate its mechanical integrity.

Why it is better

Lithium polymer batteries offer cost and performance advantages over other types of batteries; however, today's solid polymer batteries can operate only at elevated temperatures because the solid polymer electrolytes have unacceptable ionic conductivities below 60°C. Below this temperature, higher conductivity can be achieved by adding solvent to the polymer electrolyte, but the solvent compromises the electrolyte's dimensional and thermal stability. The resulting gel system requires elaborate packaging, and flammability is a concern.

Glenn's electrolyte material promises to solve these problems. While Glenn researchers continue to develop the rod-coil material to improve its performance, they already have achieved some impressive results. Figure 3 shows conductivity versus temperature curves for Glenn's rod-coil material compared to state-of-the-art PEO material. The rod coil material's curve is flatter as a function of temperature. Thus, at lower temperatures it has significantly higher conductivity than PEO. Remarkably, at 20°C the rod-coil material has almost an order of magnitude greater conductivity. It is important to note that NASA's results are for solvent-free samples.

Patents

NASA's Glenn Research Center has patented this technology (U.S. Patent No. 6,881,820).

Licensing and Partnering Opportunities

This technology is part of NASA's Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to inquire about the licensing possibilities for the Polyimide Rod-Coil Block Copolymers As Membrane Materials For Ion Conduction technology (LEW-17299-1) for commercial applications.

For More Information

For more information about this and other technology licensing opportunities, please visit:

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